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Occupational Cognitive Failure and Its Relationship With Unsafe Behaviors and Accidents

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Objectives. *The aim of this study was to assess the relationship between occupational cognitive failures (OCFs) and unsafe behaviors, accidents and driving offences among municipal bus drivers in Tehran, Iran.* ***Methods.*** *Systematic random sampling was used to select 190 drivers from 3 transport and traffic Tehran districts. Data were collected with the occupational cognitive failure questionnaire (OCFQ), the driver behavior questionnaire and a data collection form.* ***Results.*** *The mean (*SD*) numbers of driving-related offences and road traffic accidents were 1.5 (2.6) and 0.37 (1.0), respectively. The mean (*SD*) numbers of deliberate driving violations, unintended violations, driving slips and mistakes were 6.97 (5.5), 1.61 (1.5), 13.6 (9.0) and 4.53 (3.28), respectively. The mean (*SD*) number of the OCFs was 28.9 (20.5). A significant correlation was found between occupational cognitive error and unsafe driving behavior subscales. The stepwise logistic regression results showed that, while controlling the effects of confounding factors, the OCF predicts 6%, 9%, 15% and 9% of deliberate violations, unintended violations, driving slips and driving mistakes, respectively.* ***Conclusion.*** *The results of this study show that the score of the OCFQ is a predictor of unsafe driving behaviors and its subscales.*

occupational cognitive failure unsafe driving behavior accident

1. INTRODUCTION

Road traffic injuries cause health and financial losses in different societies. However, developing countries suffer disproportionately [1]. Road traffic injuries are the third leading cause of death in Iran, and the rate of road accidents is 20 times over the world's average [2]. Mortality rate of road traffic injuries in Iran is the highest in the world (30–40 per 100 000 population) [3].

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The human factor is the predominant cause of accidents. Human error caused road traffic accidents in over 70% of cases [4]. A distinction between error and violation should be made when considering the role of human factor in accidents. Error and violation may have different psychological origins and dealing with each of them may require different interventions and different modes of remediation [5]. Safe driving is not only related to driving without errors, but intentional violations and risky behaviors are also important components in safety driving [6]. Unsafe behaviors originate from failures of information processing and action execution and also from deliberate deviations from rules and procedures. Therefore, when considering the importance of violation, a model of unsafe behavior, cognitive failures, intentional rule-breaking and factors causing unsafe behavior should be considered [7].

Errors result from temporary distortion in information processing or cognitive functioning in humans [8]. Cognitive failures have been defined as cognitive-based errors in simple tasks that a person should be able to complete [9, 10]. Cognitive failure rate may be an indicator of an information processing capacity of humans and could influence the performance of tasks. Cognitive failures contribute to safety and accidents [11, 12].

The public health system is responsible for ensuring safety of public transport in each country. The knowledge of professional driving behavior is scarce [13] and although drivers are more exposed to accidents [14], relatively little research has been done to examine the driving behaviors [13]. Studies investigating driving behaviors and their associated factors among public vehicle drivers in Iran are scarce [14, 15]. Therefore, the aim of this study was to assess the relationship between the occupational cognitive failure (OCF) and unsafe behaviors, accidents and driving offences among drivers of municipal buses in Tehran, Iran.

2. METHODOLOGY

This study was cross-sectional; it examined the association between the OCFs and unsafe behaviors, road traffic accidents and driving violations among drivers of municipal buses in Tehran (February–June 2012).

2.1. Data Collection

A general data collection form included questions on demographic and work-related information: age, education, marital status, driving history, history of driving a municipal bus, daily working hours and work shift schedule, smoking habit, wearing eyeglasses, medical history, history of using medication, severe emotional problems, number of driving offenses (traffic tickets) in the past 3 years and number of road traffic accidents in the past 3 years.

The OCF data were collected with the occupational cognitive failure questionnaire (OCFQ). The cognitive failure questionnaire (CFQ) measures self-reported failures in perception, memory and motor function [16]. The Iranian version of the CFQ was developed in 2011 [17]. The content validity index assessed the questionnaire's validity. The total score of the CFQ and its extracted subscales were measured with Cronbach's α and showed high levels of reliability [17]. The Iranian version of the CFQ was translated from the original CFQ [16]. The OCFQ contains 29 questions on memory, attention, action and estimation (depth, distance and weight), e.g., "How often do you have problems with memory (e.g., forgetting where you put things), attention (failures of concentration) or action (doing the wrong thing) at work?". There were no time intervals while measuring the failures because it would be difficult for the participants to remember slips of memory for long periods. The participants graded their past failures on a 1–5 Likert scale (1 = *never*, 5 = *very often*). The participants' scores ranged from 0 to 100 [17].

The driver behavior questionnaire (DBQ) assesses driving behaviors [18]. It includes 50 items describing a variety of errors and violations during driving. Participants had to indicate on a 5-point scale (1 = *never*, 5 = *nearly all the time*) how often each aberration occurred during the past year. Winter and Dodou conducted a meta-analysis on publications related to the DBQ as a predictor of accidents. According to their results, the DBQ predicts individual differences in accident involvement; however, this cannot be proved because the results in different studies are heterogeneous [6]. The DBQ defines errors as consisting

actions that are not planned, violations as deliberate deviations from safe driving behaviours (e.g., speed) [19], slips as errors of execution and lapses as errors of storage [14]. However, slips and lapses are not considered to affect overall road safety [19]. The Iranian version of the DBQ was developed in 2011 [15]. Oreyzi and Haghayegh's study showed that the DBQ could be used as a valid and reliable tool to assess driving behaviors in Iran [15]. Four dimensions related to driving behaviors were included in the questionnaire: deliberate violations, unintended violations, driving slips and mistakes.

2.2. Participants

The participants of the study were municipal bus drivers who had at least 3 years of working experience and were still working. Municipal bus drivers who were illiterate, had Alzheimer or psychiatric problems, had under 3 years of working experience, were addicted, were physically or mentally handicapped, took medications or were ill were excluded. This information was obtained on the basis of the drivers' medical reports.

The United Bus Company of Tehran has 15 transport and traffic districts, which are divided into 4 districts with a traditional bus line system and 11 districts with new bus rapid transit. This study was conducted in the traditional bus line system because the bus rapid transit system protects against committing driving errors and violations. The sample size was calculated on the basis of the prevalence of cognitive failures (obtained from a pilot study of 44 drivers), considering the precision of 0.05% and type I error of 95%. Of the 190 questionnaires given to drivers, 151 were returned. Of the 151 returned questionnaires, 22 were excluded because of the exclusion criteria or incomplete answers, and 129 questionnaires were analyzed. Systematic random sampling selected 129 drivers from three transport and traffic districts (46 from district 6, 29 from district 7 and 54 from district 9). The questionnaires were filled in groups of 4–6 drivers (during breaks). An interviewer explained the purpose of the study and distributed the questionnaires.

2.3. Data Analysis

SPSS version 15 was used for data analysis. The data analysis was done with descriptive statistics. Spearman correlation and stepwise logistic regression assessed the association between the OCFs and unsafe driving behaviors, road traffic accidents and driving violations (measured with the number of traffic ticket). The level of significance was .05.

2.4. Ethics

The study procedures and objectives were explained to the participants. The participants were ensured that the data were confidential and only investigators would have access to them and they would face no disciplinary action for their responses, nor would the data be analyzed on an individual basis. The participants gave their verbal consent before the study.

3. RESULTS

The internal consistency of the CFQ, DBQ and its subscale scores was calculated with Cronbach's α. The results indicated internal consistency of .96 for the CFQ and .96 for the DBQ. The subscale of the DBQ had an internal consistency of .77 for deliberate violations, .61 for unintended violations, .87 for driving slips and .69 for mistakes. The results show acceptable levels of internal consistency for unintended violations and desirable levels of internal consistency for the other parts of the questionnaire.

Of 190 questionnaires given to the drivers, 151 (79.5%) drivers filled the questionnaire. Of 151 drivers who filled the questionnaire, 22 (14.6%) were excluded from the study and 129 (67.9%) drivers participated in the study. Table 1 shows demographic, work and health characteristics of the participants. The mean (*SD*) age of the participants was 41.9 (5.6) years (range: 29–55). The participants' mean (*SD*) working experience was 17.7 (6.2) years (range: 9–35) (Table 1).

Table 2 shows data on driving-related offences (traffic tickets) and road traffic accidents in the past 3 years. The mean (*SD*) number of driving-related offences was 0.4 (1.0) and the mean (*SD*)

TABLE 1. Characteristics of Participants (*N* = 129)

Characteristic	*N* (%)
Marital status	
single	4 (3.2)
married	125 (96.8)
Education	
illiterate or primary school	14 (10.9)
middle school	52 (40.3)
secondary school and higher	63 (48.8)
Work hours	
≤8	63 (48.8)
>8	66 (51.2)
Smoking	41 (31.8)
Wearing eyeglasses	29 (22.5)
Severe emotional problems	19 (14.7)

number of road traffic accidents was 1.5 (2.6). The mean (*SD*) deliberate driving violation was 7.0 (5.5), the mean (*SD*) unintended violation was 1.61 (1.6), the mean (*SD*) number of driving slips was 13.6 (9.0), the mean (*SD*) number of mistakes was 4.5 (3.3) and the mean (*SD*) number of the OCF was 28.9 (20.5). Table 3 shows the dimensions of the unsafe driving behaviors. Driving slips (.74) and deliberate violations (.56) had the highest values of Spearman correlation.

Spearman correlation examined the relationship between cognitive failures and total number of accidents. Table 3 shows that there were significant correlations between occupational cognitive errors and unsafe driving behaviors (deliberate violations, unintended violations, driving slips and mistakes) (p <.05), but there was no significant correlation between the OCF and driving accidents or between the OCF and driving offences (measured with the number of traffic tickets).

Stepwise multiple regression analysis assessed, the relative contribution of cognitive failure to each subscale of unsafe driving behavior after adjustment for demographic variables. Demographic variables (including age, education, working experience and marital status) were entered into the regression model to control their relationships with the dependent variables. Demographic variables were entered in step 1 and the cognitive failures in step 2. The stepwise logistic regression results showed that while controlling the effects of confounding factors, the OCF predicted 6%, 9%, 15% and 9% of the risk of deliberate violations, unintended violations, driving slips and driving mistakes, respectively (Table 4).

TABLE 2. Driving Offences and Road Traffic Accidents in the Past 3 Years

Dimension	*M* (*SD*)	Range	Max Score (DBQ)
Driving accident	1.5 (2.6)	0–13	—
Driving offence	0.4 (1.0)	0–7	—
Deliberate violation	7.0 (5.5)	0–23	56
Unintended violation	1.6 (1.6)	0–7	12
Driving slip	13.6 (9.0)	0–46	84
Mistake	4.5 (3.3)	0–13	36
Occupational cognitive failure	28.9 (20.5)	0–113	116

Notes. DBQ = driving behavior questionnaire.

TABLE 3. Correlation Between Occupational Cognitive Failure (OCF) and Driving Accidents, Driving Offences and Unsafe Driving Behaviors

	OCF	
Dimension	Spearman Correlation	*p*
Driving accident	−.18	.03
Driving offence	.10	.27
Deliberate violation	.40	.00
Unintended violation	.56	.00
Driving slip	.74	.00
Mistake	.56	.00

TABLE 4. Results of Stepwise Logistic Regression

	OCF			
Dimension	**Coefficient**	***SE***	***p***	***OR***
Deliberate violation	.055	.012	.000	1.06
Unintended violation	.083	.015	.000	1.09
Driving slip	.140	.020	.000	1.15
Mistake	.089	.015	.000	1.09

Notes. OCF = occupational cognitive failure, *OR* = odds ratio. Step 1 of stepwise logistic regression = age, education, working experience and marital status, step 2 of stepwise logistic regression = cognitive failures.

4. DISCUSSION AND CONCLUSION

This study is the first Iranian research to develop prediction of unsafe driving behaviors and driving accidents among municipal bus drivers by measuring the cognitive failure and its associations with unsafe driving behaviors. Many studies developed an association between cognitive failure and accidents, but mostly occupational accidents [17, 20, 21, 22, 23]. The results of this study show a high level of unsafe driving behaviors. Driving slips (.74) and deliberate violations (.56) had the highest values of Spearman correlation. The mean deliberate driving violations was 7.0, the mean unintended violations was 1.61, the mean number of driving slips was 13.6, the mean number of mistakes was 4.5. A study on 443 Australian volunteers included three categories of driving behavior factors (the mean error factor were 1.61, the highway code violations were 1.7 and the mean aggressive violations was 1.53), which were lower than the unsafe driving frequencies in the present study [24]. Reason, Manstead, Stradling, et al. also showed a minimum 3-fold lower unsafe driving behavior frequencies [5], but they used a different version of the DBQ questionnare with different subscale that might make comparing the results difficult. In the present study, the mean OCF score was 28.9 and was similar to Allahyari, Saraji, Adl, et al.'s findings, which showed that the mean score of the CFQ was 27.9 [14]. The mean OCF score in the present study is lower than the mean cognitive failure reported by Wallace and Vodanovich [12], who measured the cognitive failure in relation to driving accidents (the mean score was 43.4) and Matthews, Coyle and Craig [25], who measured the cognitive error in relation to stress (the mean score was 45.0), but greater than the mean cognitive failure score reported by Larson, Alderton, Neideffer, et al. [9].

The results of the present study show a significant correlation between the OCFs and unsafe driving behaviors (deliberate violations, unintended violations, driving slips and driving mistakes). This finding is in step with Allahyari et al., who showed a significant correlation between the CFQ score and driving error rates measured with the driver error questionnaire [14]. Allahyari et al. also concluded that the CFQ score was a significant predictor of driving errors [14]. Winter and Dodou meta-analysis reported that there was a positive correlation between self-reported accidents and errors in 32 of the sampled studies and violations in 42 of the sampled studies. They concluded that both errors and violations correlated positively with self-reported accident involvement [6].

The present study did not show any significant correlation between the OCF and driving accidents or between the OCF and driving offences (measured with the number of traffic tickets). These findings agree with the findings of Allahyari et al., who reported that an overall score of cognitive failures was not a good predictor of accidents [14]. Blockey and Hartley also reported that neither errors nor violations were significant predictors of accidents [26]. However, some studies reported a significant correlation between the CFQ score and accident [6, 27]. No correlation between the CFQ score and driving accident may be a result of considering the CFQ total score and not the CFQ subscales score. Allahyari et al. showed that there was a correlation between

the CFQ subscale and specific type of accident; however, further study is necessary to research this problem [14].

The result of this study showed that cognitive failure was a better predictor of driving slips and a poorer predictor of deliberate violations. Cognitive failure affects mostly driving behaviors that are not deliberate. Allahyari et al. also showed a strong and positive correlation between cognitive failures and driving error rates and confirmed that people with more cognitive failure commit more driving errors [14]. Stradling, Parker, Lajunen, et al. showed that violations, not errors, predict accidents, which may explain why the CFQ was not related to accidents, as the CFQ score mostly affects errors not violation [28].

One of the limitations of the present study is its reliance on self-reporting of the accidents and driving errors. Allahyari, Rangi, Khosravi, et al. criticized self-reporting because the obtained data were imprecise because of memory distortions and anonymity, social desirability bias in responses and confidentiality issues [17]. However, some studies showed that self-reporting errors and accidents was reliable and accurate [12, 29, 30].

The findings of the present study showed that the CFQ score is a predictor of driving behaviors and its subscales but not accidents or driving offences. The small sample size, because of difficulty in accessing municipal bus drivers, was one of the main limitations of this study. The participants of the present study can be considered as a sample group of all the municipal bus drivers in Tehran, Iran.

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